

I-NURSE: Identifying and Automatically Detecting Topics in Nursing Handover Communications

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Chapter I. Statement of the Problem

Patient handovers have been described as the process of transferring primary authority and responsibility for providing clinical care to a patient from one departing caregiver to one oncoming caregiver.¹ Evidence of a correlation between effectiveness of patient handovers and patient outcomes is becoming apparent. For example, poor handovers have been associated with adverse events, delays in treatment and diagnosis, unnecessary communication, decreased patient and provider satisfaction, more time spent in hospital, increased hospital admissions, higher costs, and less effective training for healthcare providers.^{2, 3}

Patient handovers have been repeatedly identified as critically important in ensuring patient safety. Patient handovers with incomplete and inaccurate information have repeatedly been identified as a patient safety risk. Approximately 20-30% of information conveyed during handovers is not documented in the medical record.⁴⁻⁶ Impacts of less-than-ideal patient handovers are assumed to include adverse events, delays in medical diagnosis and treatment, redundant communications, redundant activities such as additional procedures and tests, lower provider and patient satisfaction, higher costs, longer hospital stays, more hospital admissions, and less effective training for healthcare providers. Several observational, focus group, and survey studies have found that patient handover processes are highly variable in quality and structure.⁷⁻¹³

In 2009, The Joint Commission devised a national patient safety goal to standardize handover communication in an effort to improve handovers.¹⁴ The most common interventions performed to meet this goal were designed to improve content order, thoroughness and comprehensiveness of communication of patient goals, events

and identifiers.¹⁵ The World Health Organization published guidelines for physician handovers;¹⁶ these were endorsed by the Society of Hospital Medicine and the Accreditation Council for Graduate Medical Education; these guidelines focus on content order conformity during handovers.¹⁷⁻¹⁹ The most common ordering mnemonic in the past is SBAR (Situation Background Assessment Recommendation).²⁰

However, recently a study using the mnemonic IPASS (**I**llness Severity, **P**atient Summary, **A**ction List, **S**ituation Awareness/Contingency Planning, and **S**ynthesis by Receiver) found that post-intervention the use of these strategies decreased medical errors by 23% and the rate of preventable adverse effects by 30%.²¹ The coding analysis used in the IPASS study and many others can be time consuming and cost-ineffective.²²

As a result there is a desire to automate this analysis. The software Linguistic Inquiry and Word Count (LIWC) is an automated textual analysis software package.²³ In essence, LIWC analyzes written or transcribed text files by matching words within the text file to an internal dictionary or user generated dictionaries.²⁴ In addition to other domains, LIWC has been used to analyze cockpit communication, empirical dialog-state modeling, and Federal Reserve Chairmen transcripts.²⁵⁻²⁷ LIWC software has the potential to be a cheap automation option for word analysis work.

The most effective nursing handover method is yet to be determined since research studies are inconclusive when evaluating nursing handovers and consequently requires improvement in study design to make further evaluations.²⁸ Researchers noted the absence of randomized controlled studies to evaluate nursing handover effectiveness and recommended this study design as a high priority in determining best practice.²⁸ Evidence does support certain aspects of handover design including face-to-face

communication, structured documentation, patient involvement, and use of IT technology to support the process.²⁸ There are opportunities available to better support patient handovers using electronic health records (EHRs) by automatically displaying information that is already present in disparate areas of the system.

Chapter II. Literature Review

The Cumulative Index of Nursing and Allied Health Literature was searched for the following terms: (hand AND off) OR handoff OR handover OR (shift AND change) AND ((electronic AND health AND records) OR (electronic AND medical AND record) OR (computerized AND patient AND record)). The search was limited to the past 5 years and the English language.

Electronic Health Records and Nursing Handovers

EHRs have made it possible to selectively examine patient records for pertinent information, which can significantly aid handover presentation.²⁹ Though EHRs are effective in providing information during a handover, they may lack in aiding a patient's "full story."³⁰

There is a push for a more standardized handover to improve accessibility for health care team members and to improve patient care.^{31, 32} Indeed, a study that examined SBAR and its impacts found improved overall documentation with SBAR mediated EHR.³³ There is evidence that EHRs have the potential to improve handovers, and patient safety.³⁴

However, one study notes that increased structure has the potential to leave out important clinical information.³⁵ And although documentation can be increased with EHR adoption, many nurses find that the transition from paper to electronic records difficult, as a balance must be struck between documentation and actual discussion.³⁶

Nurses have limited use for EHR tools as they are now; many are physician oriented and do not take nurse needs as much into account.^{37, 38} This can be an issue with

handovers specifically as nurses and physicians have been shown to have different training and focus in their handovers.³⁹

Chapter III. Methodology

This study was approved by Ohio State University's Institutional Review Board. 20 existing transcripts from a previously IRB-approved data collection of audio-recorded Intensive Care Unit Registered Nurse handovers containing 27 patient discussions collected from a single, academic tertiary care institution were analyzed for this study.

Specific Aim 1: Evaluate nurse adherence to IPASS

First all 20 transcripts were manually coded using a codebook adapted from Starmer et. al's paper *Changes in Medical Errors after Implementation of a Handoff Program*.²¹ The codebook in Figure 1 was used to evaluate nurse's basal levels of adherence to IPASS, which was originally developed for physicians. The noise category was used to classify any communication that did not fit into one of the five IPASS categories.

Code	Meaning	Description	Examples
I	Illness Severity	Severity of patient's present illness. <ul style="list-style-type: none"> • Focus attention appropriately • Use standard language • A continuum 	<ul style="list-style-type: none"> • Stable • "Watcher" • Unstable
P	Patient Summary	Summary statement; events leading up to admission; hospital course; plan <ul style="list-style-type: none"> ▪ Describes succinctly: <ul style="list-style-type: none"> • Reason for admission (summary statement) • Events leading up to admission • Hospital course • Ongoing Assessment • Plan for hospitalization ▪ Is concise, utilizes semantic qualifiers, focuses on active issues ▪ Broad category; most current or past patient information. 	<ul style="list-style-type: none"> ▪ "So on the 21st, started this four-day history of shortness of breath." ▪ "He had chest pain" ▪ "So moving on to respiratory, so he's on CPAP..."
A	Action List	To do list; timeline and ownership <ul style="list-style-type: none"> ▪ To do list ▪ Includes specific elements: <ul style="list-style-type: none"> • Timeline • Level of priority • Clearly-assigned responsibility • Indication of completion ▪ Needs to be up-to-date ▪ If no action items anticipated, clearly specify "nothing to do" <p>Essentially future plans for patient care.</p>	<ul style="list-style-type: none"> • "I think in four days -- the four days will be up on that peripheral tomorrow." • "I think they'll probably SVT him again in the morning. They may consider extubating him." • "I would guess that they want to rest him on AC over."
Sa	Situation Awareness & Contingency Planning	Know what's going on; plan for what might happen. Draws receiver's attention to <ul style="list-style-type: none"> • Worrisome patients • Potential problems ▪ Ensures accepting team is prepared to anticipate and respond to changes in patient status ▪ Promotes a shared mental model ▪ May take the form of if-then statements 	<ul style="list-style-type: none"> ▪ "If you need to do it, you pop her off the ventilator..." ▪ "If you are going to do that, have them show you."
Sb	Synthesis by Receiver	Receiver summarizes what was heard, asks questions, restates key action/to do items <ul style="list-style-type: none"> ▪ Brief re-statement of essential information in a cogent summary <ul style="list-style-type: none"> • Demonstrates information is received and understood ▪ Opportunity for receiver to <ul style="list-style-type: none"> • Clarify elements of handoff <p>Have an active role in handoff process</p>	<ul style="list-style-type: none"> ▪ None seen in sample

Figure 1. IPASS Codebook

An inter-rater reliability test was performed using four randomly selected handovers. The initial Kappa score, which provides a measure of the degree to which two independent judges concur in categorizing mutually exclusive categories, was 0.55. This indicates moderate agreement (in the range 0.41-0.60), and consensus was reached for all coding discrepancies through discussion.⁴⁰

Specific Aim 2: Develop Novel Codebook and Evaluate Against IPASS

A novel codebook was manually generated from the transcripts in an effort to more accurately model nurse handovers. The categories which emerged were grouped into INURSE (Identification, Narrative, Unusual Symptoms, Response, Status, Expected Challenges). The codebook is shown in Figure 2.

Code	Sub code	Meaning	Description	Examples
I	IDN	Identification name	Patient's name	<ul style="list-style-type: none"> Teddy Smith, he go by, he goes by Ted
	IDR	Identification room	Patient's current room number.	<ul style="list-style-type: none"> Okay, 864
	IDA	Identification age	Patient's current age.	<ul style="list-style-type: none"> Yeah, he's 54 55 year old
N	NH	Narrative History	Broad information that brought the patient to his or her current status. <ul style="list-style-type: none"> The events that brought the patient to the hospital. The events that have occurred since admission. Often takes the form of non-nurse tasks. Includes past medical history 	<ul style="list-style-type: none"> Um, he's a full code. No known drug allergies. Past medical history he has a necrotic syndrome, he's a Hep C, diabetes, in the past year the leg compartment syndrome. Essentially he came in today. Um, he was taken to the OR to have his stent removed with a rigid bronch.
	NF	Narrative Family	Information concerning the patient's family that does not occur in the form of warnings.	<ul style="list-style-type: none"> I don't think that the family was too happy with his stay in Florida
U	USR	Respiratory Status	Description of symptoms and results relevant to respiratory function.	<ul style="list-style-type: none"> Respiratory wise, he's clear, he is on 2 liters.
	USC	Cardiac Status	Description of symptoms and results relevant to cardiac function.	<ul style="list-style-type: none"> So, um, heart rate here, he's been sinus tachy for me.
	USN	Neurological Status	Description of symptoms and results relevant to neurological function.	<ul style="list-style-type: none"> He is alert and oriented Like I said neurologically he, he didn't arouse to voice
	USGi	Gastrointestinal Status	Description of symptoms and results relevant to gastrointestinal function.	<ul style="list-style-type: none"> Bowel sounds are there
	USGu	Genitourinary Status	Description of symptoms and results relevant to genitourinary function.	<ul style="list-style-type: none"> he is anuric, for him
	USIn	Integumentary Status	Description of symptoms and results relevant to integumentary function.	<ul style="list-style-type: none"> Um, skin wise, his bottom and everything, all the skin looks fine Skins intact
	USIv	IV Port Status	Description of current IV ports and their functioning.	<ul style="list-style-type: none"> And he has a right forearm 20 gauge too 1 18 in the left hand and a 22 that work just fine
R	RC	Response to Care	How patient responds to care such as various medications or foods, how the patient likes to be moved.	<ul style="list-style-type: none"> So, and he seems to be comfortable with this, I mean if you turn him and mess with him he'll move around but he seems to calm down
	CS	Communication Status	Communication among various caregivers and family. <ul style="list-style-type: none"> The physician's communication with the family; the nurse's communication with the physician. Discharge instructions 	<ul style="list-style-type: none"> I haven't heard back from him if... So the attending actually called the wife and the son

			given to the patient	
S	SF	Tasks to be Completed	Concerning the future of the patients care such as discharge and administrations. May also include ongoing tasks.	<ul style="list-style-type: none"> And the plan is for colonoscopy
	SP	Tasks Already Completed	Tasks done by the outgoing nurse that may affect the incoming nurse's task list. Typically associated with a time the task was done.	<ul style="list-style-type: none"> I drew this at 2142 because he was getting all this blood I had to bump him down to 30 mics because his blood pressure was in the 70's systolically
	SC	Status Check	Inquiries of understanding from outgoing or clarifying questions from incoming. <ul style="list-style-type: none"> Most questions from either party. 	<ul style="list-style-type: none"> Any questions you have? No? Okay
E	EP	Expected Patient Challenges	Patient related warnings given to incoming nurse.	<ul style="list-style-type: none"> He does circles in there when he sleeps. Like at one point in time, all of his leads and stuff were off.
	EF	Expected Family Challenges	Family related warnings given to incoming nurse.	<ul style="list-style-type: none"> Yeah. I guess they've had a little issues with the family.
O	OFF	Off-Topic	Discussions unrelated to the patient that take place during the handoff. <ul style="list-style-type: none"> Workflow discussions Social discussions 	<ul style="list-style-type: none"> <u>I'm giving Anne two more minutes to show up.</u> <i>What happened?</i> She's waiting for Anne. This is my first day back from vaca. So I'm kind of like. I kind of got my butt kicked today
NO	NO	Noise	Conversations that does not fit into any other category.	<ul style="list-style-type: none"> INCOMING: This guy, I feel bad for him for having to wait so long

Figure 2. INURSE Codebook

All 27 handovers were coded using the novel codebook. This was done so a comparison could be made between INURSE and IPASS in how effectively they model a nurse handover.

The coding was validated by an inter-rater reliability test using 3 randomly selected handovers with a Kappa score of 0.84, which indicates agreement between coders (0.81-0.99).⁴⁰

Specific Aim 3: Code Transcripts Using LIWC Software and Compare with Manual Coding

In order to test the feasibility of automated text analysis using simple text analysis, Linguistics Inquiry and Word Count Software (LIWC) was acquired. LIWC is automatic textual analytic software capable of customized outputs. The main type of outputs used in this study was a “tag” output. The tag output redisplay the document with the words in a user-generated dictionary highlighted or tagged. An example of the tag output may be seen in Figure 3.

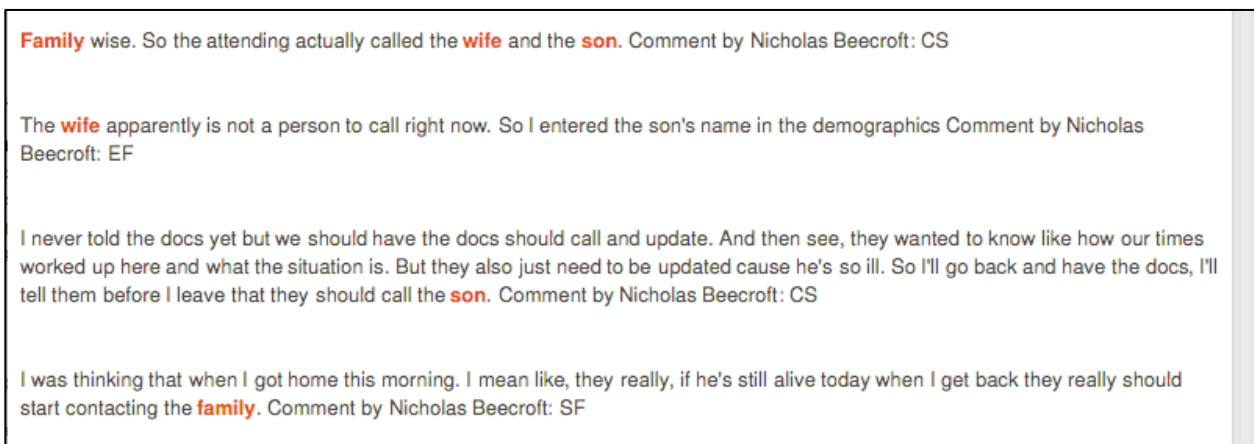


Figure 3. LIWC Highlighting Term Example

This software was used to identify family terms that fell under the INURSE codes Narrative Family and Expected Family Challenges. The unique dictionary “Family” was generated for this analysis as can be seen in Figure 4.

Family Topic
family
wife
husband
sister
brother
daughter
son
mom
dad
mother
father
children
child
kid

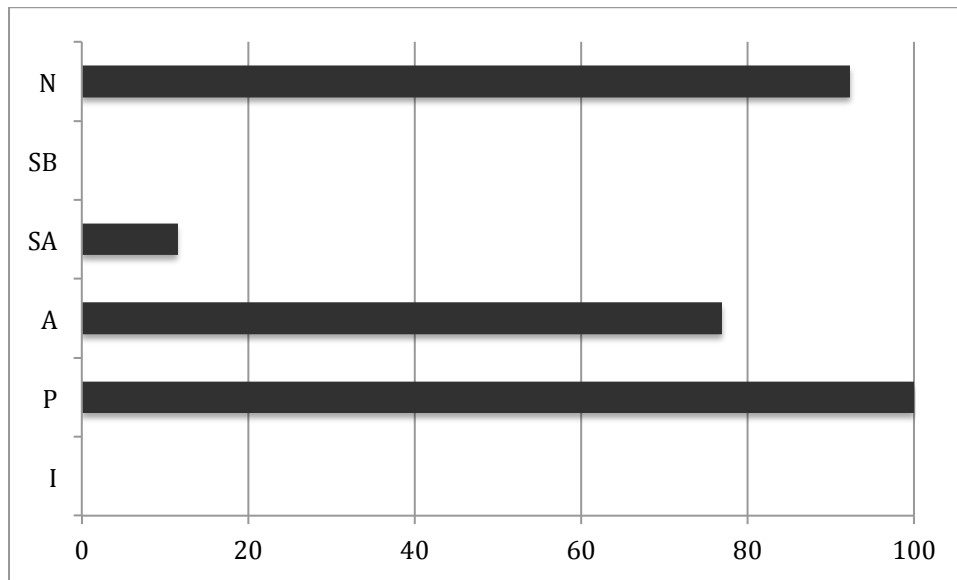
Figure 4. Words Contained in LIWC Dictionary Family

The manually coded transcripts were the gold standard against which the LIWC coded transcripts were compared. The LIWC transcripts were investigated for misses – in which no highlight was present for a manually identified Narrative Family or Expected Family Challenges code – and false positives – in which the LIWC software highlighted a word that was not associated with a manually coded NF or EF code.

Chapter IV. Findings

Specific Aim 1: Evaluate nurse adherence to IPASS

The handover transcripts were evaluated for the presence of each IPASS code. In Figure 5, for example, at least one instance of Action list was found in 77% of the handovers and no instances of Synthesis by Receiver were found in any handovers.



N is Noise, I is Illness Severity, P is Patient Summary, A is Action List, SA is Situation Awareness & Contingency Planning, SB is Synthesis by Receiver.

Figure 5. Incidence of IPASS in Handovers

Specific Aim 2: Develop Novel Codebook and Evaluate Against IPASS

The handover transcripts were evaluated for the presence of each INURSE code in the same way as Specific Aim 1. Then, each IPASS category was matched with all INURSE codes that corresponded to it. As can be seen in Figure 6, P corresponds with SP, RC, USIv, USIn, USGu, USGi, USN, USC, USR, NH, IDA, IDR, and IDN. Essentially every part of the handover that was described as P can be described with the above INURSE categories. Though P was seen in every handover, no single one of the INURSE codes that collectively describe the large selection of data that P describes is present in 100% of the handovers.

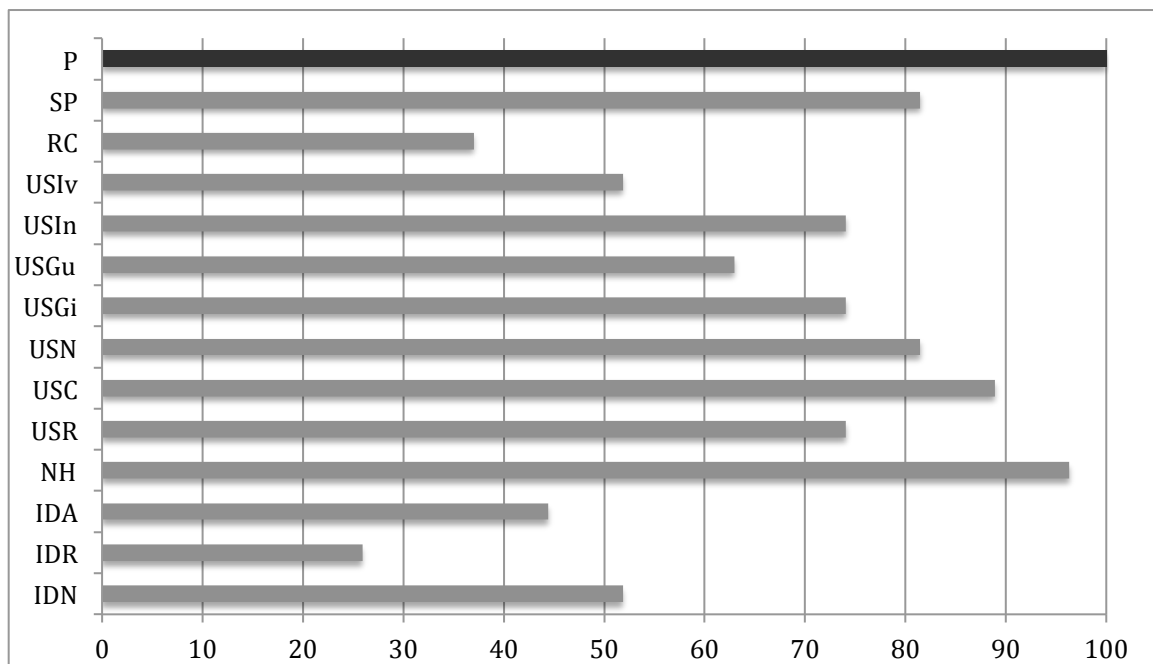


Figure 6. P Compared to INURSE Correspondents.

IPASS: P is Patient Summary

INURSE: SP is Tasks Already Completed, RC is Response to Care, USIv is IV Port Status, USIn is Integumentary Status, USGu is Genitourinary Status, USGi is Gastrointestinal Status, USN is Neurological Status, USC is Cardiac Status, USR is Respiratory Status, NH is Narrative History, IDA is Identification Age, IDR is Identification Room, IDN is Identification Name.

Figure 7 shows A and its single correspondent, SF. As can be seen, there is no meaningful difference between the two as these categories are essentially the same.

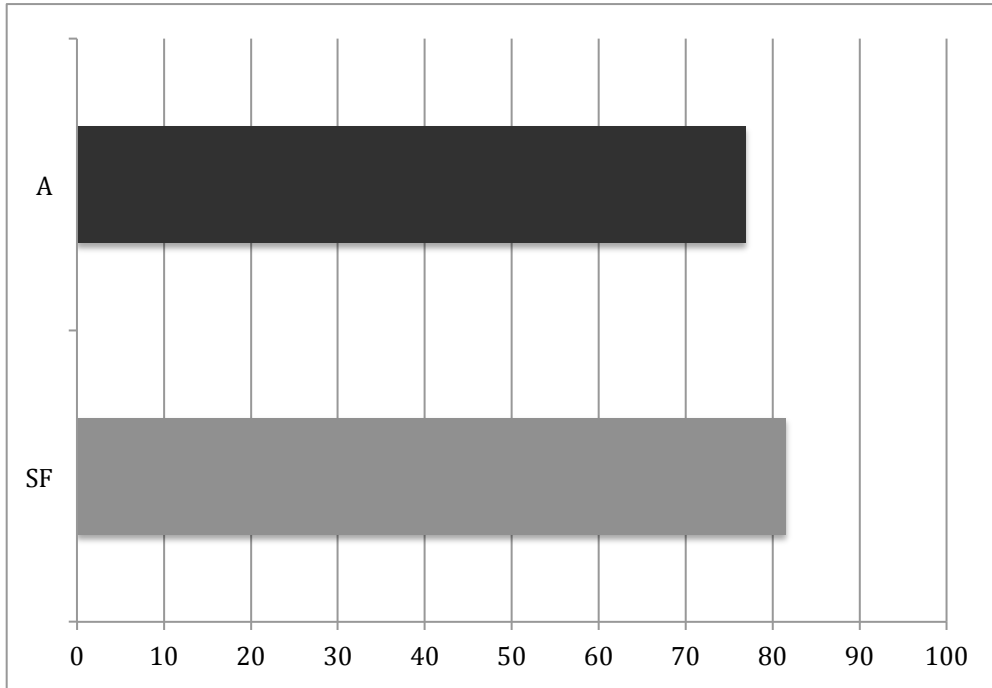


Figure 7. A Compared to INURSE Correspondent

IPASS: A is Action List

INURSE: SF is Tasks to Be Done

Figure 8 shows Sa and its INURSE correspondents.

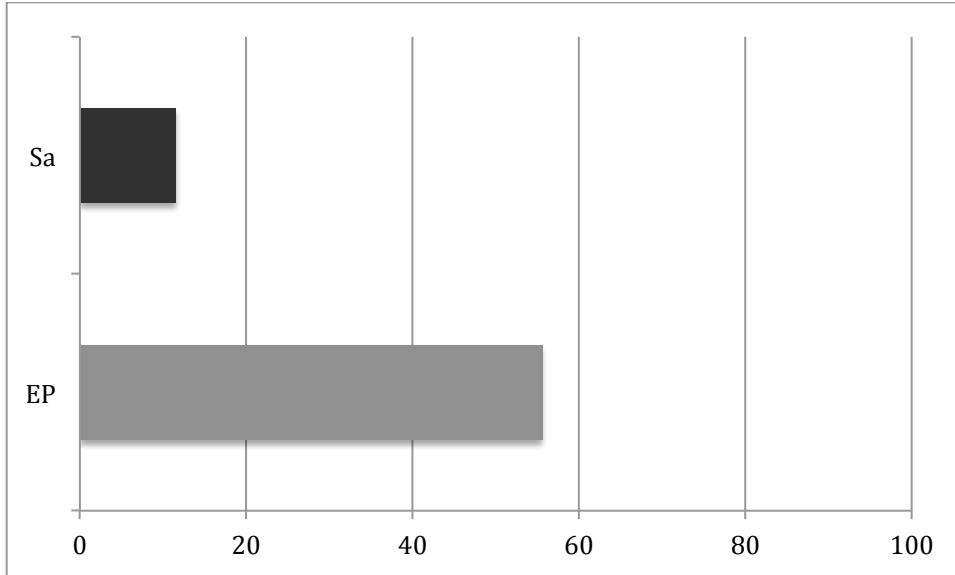


Figure 8. Sa and INURSE Correspondents

IPASS: Sa is Situation Awareness and Contingency Planning

INURSE: EP is Expected Patient Challenges.

Figure 9 shows N and its INURSE Correspondents. As can be seen, the relatively high incidence of the “Noise” category is broken up into five new categories in INURSE with few codes still classified as Noise.

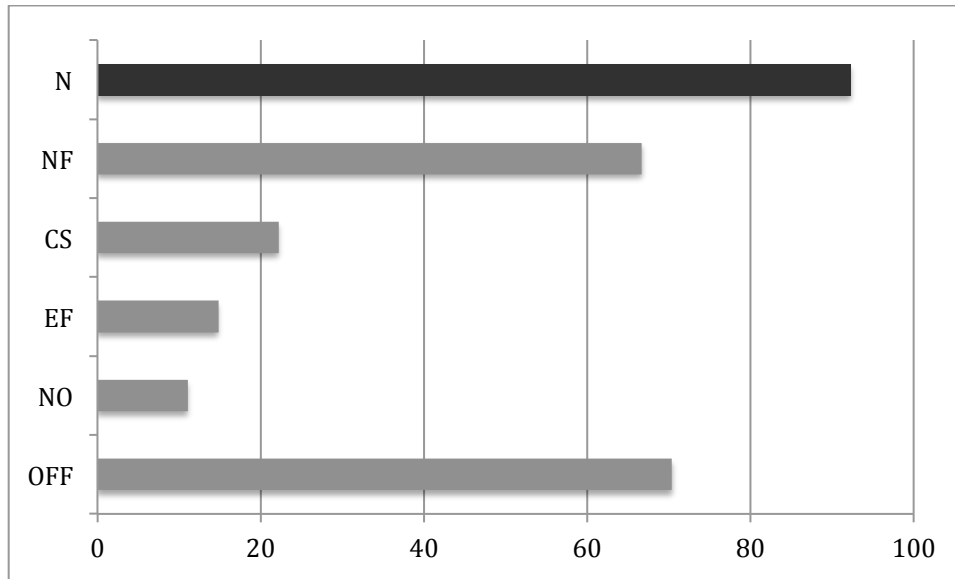


Figure 9. N and INURSE Correspondent

IPASS: N is Noise

INURSE: NF is Narrative Family, CS is Communication Status, EF is Expected Challenges Family, OFF is Off Topic, NO is Noise.

As there were no instances of I or SB seen in the analysis during specific aim 1, no INURSE codes were correspondd with those constructs.

Specific Aim 3: Code Transcripts Using LIWC Software and Compare with Manual Coding

The automatic LIWC coding was compared with the manual coding process for instances of Family as seen in NF and EF. As seen in Figure 10, there were no recorded misses, and 9 false positives found.

Topic Category	Manual Coding	LIWC
Family (Narrative Family and Expected Family Challenges)	25 (21 NF, 4 EF)	34 (9 false positive*)

Figure 10. Automatic LIWC Coding Compared to Manual Coding for INURSE

***Manual coding is the gold standard. False positives primarily in CS about communications with the patient's family.**

Chapter V. Discussion

Ultimately it was seen that Action List and Patient Summary were primarily used in IPASS with a large incidence of Noise – or sections that did not fit into any of the other five constructs. I and SB were never seen in the handovers, and Sa was seen in 11% of the handovers. The IPASS and INURSE categories were aligned with greater specificity being seen with INURSE categories, especially when looking at P. As can be seen in Figure 6, 13 distinct INURSE codes fit into the larger P. This implies that P is perhaps less effective at describing a nurse handover, as it represents the vast majority of content in a nurse handover coded with IPASS and lacks some of the nuance that INURSE provides with a more varied codebook.

The categories in each codebook that describe the future of patient care, Action List and Tasks to be Done, were found to correspond strongly. This is to be expected, as there is a one-to-one relationship between these similar categories. As shown in Figure 7, there was no meaningful difference found between these two codes.

The IPASS code Situational Awareness and Contingency Planning was corresponded with Expected Patient Challenges. At first Figure 8 appears unusual as SA was seen in far fewer handovers than the INURSE category related to it. However, upon further investigation this is supported. EP comprises most warnings about the patient, and the criteria for warnings that would fit into Sa are stricter than EP. Warnings that fall under the SA category are often if-then statements or complex patient-related instruction, but any warning about the patient is contained within the EP category. This is useful, as it comprises many ideas that may not be present explicitly in the Electronic Health Records.

Overall the INURSE construct had fewer statements that were uncategorized as compared to IPASS. This can be seen in Figure 9. When coded with IPASS, 25 of the 27 handovers contained at least one statement that did not fit into one of the five other categories and was labeled as N. Much of this Noise falls under family categories, Narrative Family and Expected Family Challenges. IPASS fails to account for any descriptions of family, which is a significant part of many nurse handovers. Communication Status entails communication between different people surrounding the patient's care. This category also often has to do with family, though this is not the case every time. Noise is also described with OFF which depicts off-topic conversation such as the nurse's personal life or workflow discussion. With INURSE, there are only 3 handovers that contain at least 1 statement that cannot be accounted for as described with the code NO.

There were also two IPASS codes that were not seen at all in the nurse handovers. Illness Severity and Synthesis by Receiver were unobserved, supporting the idea that IPASS may not be a good way to describe nurse handovers. This and the differences discussed above indicate that INURSE may be better able to describe nurse handovers and points to differences between nurses and physicians especially considering IPASS was originally physician-oriented. One of the primary differences seems to be an inclusion and focus of discussion on the topic of family. There is no mention of family in IPASS.

These differences imply that INURSE is a more effective descriptor of nurse handovers than IPASS. However, IPASS was originally part of an interventional study and should INURSE be modified for training several elements could be pulled from

IPASS to strive for. For example, Illness Severity and Synthesis by Receiver could improve nurse handovers as they could help a nurse think longitudinally about the patient and critically summarize the handover respectively. Perhaps in a future interventional study something like IINURSESS could be trained to.

As discussed, INURSE was effective in explaining the transcript data; additionally the Inter-rater Reliability Test (IRR) supported its validity with a Kappa value of 0.84. The IRR in particular was a point of learning in this study. It was seen that clear communication and explicit codebooks with examples are essential for success. The failed IRR is believed to be partially due to less-than-sufficient communication between raters. This issue was addressed with the INURSE IRR and it came back with positive results.

The LIWC analysis showed that the automated software was able to correctly identify every instance of family as defined by the codes NF and EF – there were no misses. However, it did highlight several words in the Family dictionary that were not manually coded as Narrative Family or Expected Family Challenges – false positives. This software could be a reliable way to nominate family constructs for manual review. This has the potential to save significant time, as it eliminates the majority of non-family statements and included every Expected Family Challenges and Narrative Family in its highlights. However, it is important to note that Family is likely the easiest code to capture using this software. Family has distinct keywords like mother and brother. Based on a paper by Zachary Woods et al., in which LIWC software was used on a variety of categories, it seems reasonable to infer that LIWC would be successful in identifying Tasks to be Completed, Status Check, Identification Name, Identification Age, and

Identification Room, but the other categories may be too complex for the software to be effective.⁴¹ The Woods paper found constructs such as Diagnosis and Clarifying Questions unable to be coded effectively by LIWC; these may correspond well with the Narrative History, Unusual Symptom codes, and Status Check of INURSE. Ultimately while LIWC has the potential to automate some coding, in its current state it may not be capable of identifying more nuanced codes on a reliable basis.

Though the Status Check category may have been broad, it raises interesting thoughts about questions asked over the course of a handover. One study looked at active communication between different types of health care provider.⁴² A finding of that study was that nurses tended to be less assertive or subtler with their questioning of peers. As this can lead to misinterpretation, ideally nurses would be more explicit with their critical questioning. LIWC could potentially help identify questions in handovers for nurse feedback. If different types of questioning could be identified regularly, this could give nurses the tools necessary to question more explicitly through the use of collaborative cross-checks which is defined as a “question that challenges accuracy or appropriateness of diagnosis, treatment plan or prognosis” in the before-mentioned study.

This study does have a number of limitations. The sample size is rather small with 20 recorded transcripts containing 27 patient handovers. Additionally, only the transcripts were used for this study; the data was not collected by this investigator nor were the audio recordings used. This could have resulted in missing context or information. The data comes from only one hospital, so it may not be as generalizable as would be preferred. This data is also several years old and was collected when a different Electronic Medical Record was used. There was also limited clinical involvement during

the analysis; one of the raters was a medical student but he only coded three handovers for the inter-rater reliability test. This could have resulted in some misinterpretation of the data as much of it is clinically specific.

There are several opportunities to follow up on this research. LIWC software is simple software; there are far more sophisticated programs that use Natural Language Processing for greater accuracy. It could be useful to investigate this software to improve automated coding of handover transcripts. Furthermore, this coding could be beneficial to investigate more deeply the structure of handovers. Though there was variation, it was noticed that handovers started with patient identification and history and that family topics were typically towards the end.

When combined with a transcription program like Dragon, LIWC coding could have the potential to put information into the patient's chart that might not typically be there. For example, a significant portion of family discussion was about when they were coming to visit the patient. If family were automatically analyzed, visiting times might be recorded in the chart and could help physicians attend informal huddles with the family. Huddles can save time on both the family and physician's part, and with automated analysis these could potentially be done consistently.

Ultimately there are many directions this research could be taken from here from further software refinement to nurse handover training.

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